

**AFFECTED ENVIRONMENT,  
SIGNIFICANT IMPACTS  
AND  
MITIGATION MEASURES**

## AFFECTED ENVIRONMENT

Three geologic factors are required for the accumulation of commercial quantities of petroleum and natural gas. They are:

- An adequate source of petroleum-generating material in the form of organic material, e.g., marine organisms or plant life;
- The presence of reservoir rocks in which important amounts of oil and gas can accumulate and from which they can be made to flow to wells for production at satisfactory rates; and
- Suitable structural or stratigraphic conditions that provide a means of localizing and entrapping the oil and gas in the reservoir rocks.

Six areas of the state are potential areas of interest for oil and gas exploration. They are: Willapa Hills, Puget Lowland, Whatcom County, Olympic Peninsula, Columbia Basin and certain aquatic lands. The designation of these areas as having oil and gas potential is based on current state-of-the-art technology. [W4]

Until very recently oil and gas were thought to be produced from marine rocks. Recent research reveals the possibility of obtaining commercial production from nonmarine or continental rocks. In view of the changing theories of oil and gas generation, migration and accumulation, no area of the state can be ruled out as a potential area of exploration interest. However, the northeastern part of the state with extensive metamorphism (alteration of the original deposited rocks by heat and pressure), the Cascade Mountain area with extensive vulcanism and metamorphism and the metamorphic core of the Olympic Mountains appear to be unlikely sources of commercial quantities of oil or gas.

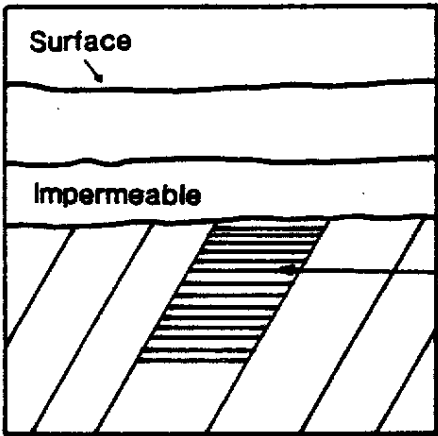
In the early days of exploration and development oil and gas were found in obvious geologic features such as anticlines. Anticlines are upward warpings or folds of the layers of rock like an arch which act as a structural trap (see Figure 1). Due to the presence of overlying rocks, the oil and gas migrates to the highest part of the fold where it is trapped by overlying impermeable rock layers. In the absence of such impermeable layers the oil and gas would migrate to the surface forming seeps and tar pits.

Early exploration was initially confined to areas where such anticlines could be readily mapped by geologists. With the drilling of more wells and the study of the results, the petroleum industry began to realize that other structural features such as faults could form a trap and stop the migration of oil and gas. A shift in the rock strata may place an impermeable rock layer across a permeable layer, forming a fault trap (see Figure 1).

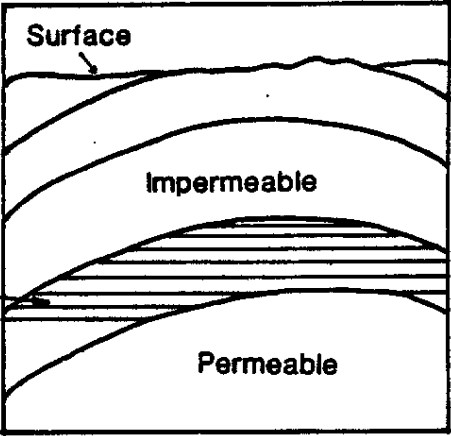
Stratigraphic traps such as pinchouts, truncations, lenses and porosity changes were also observed (see Figure 1). In a pinchout the deposition process of a permeable rock layer such as sandstone may be interrupted and the deposition of an impermeable layer such as clay may take place. Any oil or gas migrating

Figure 1. Types of Oil and Gas Traps

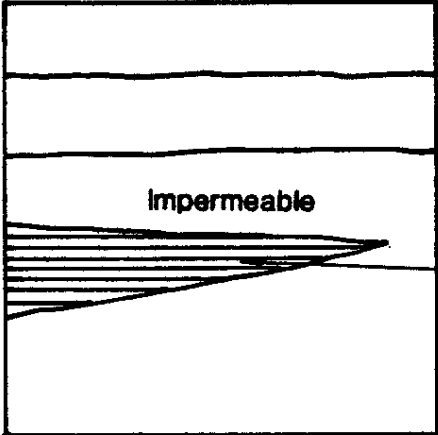
TRUNCATION



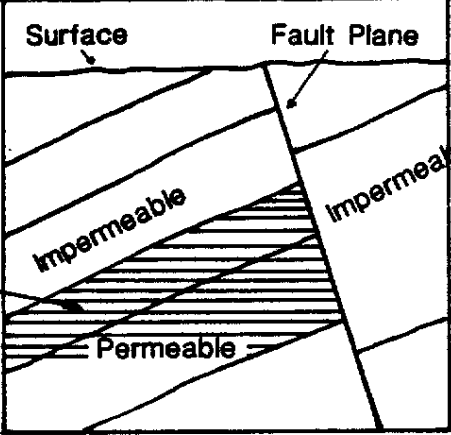
ANTICLINE



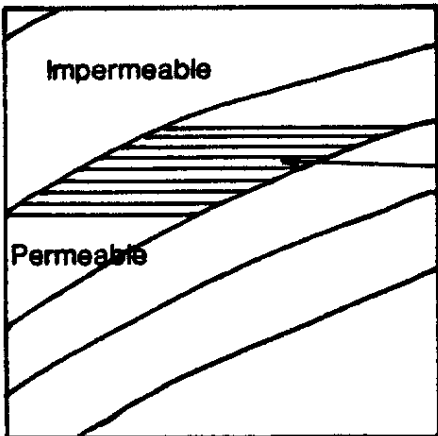
LENS



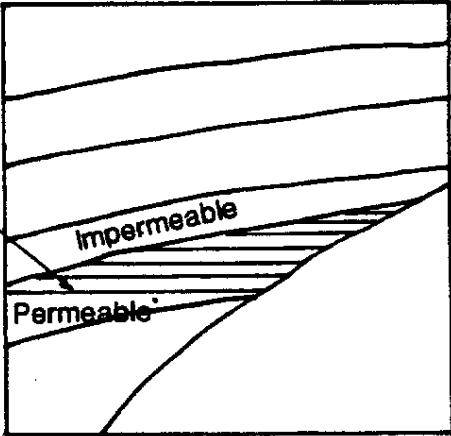
FAULT



POROSITY CHANGE



PINCHOUT

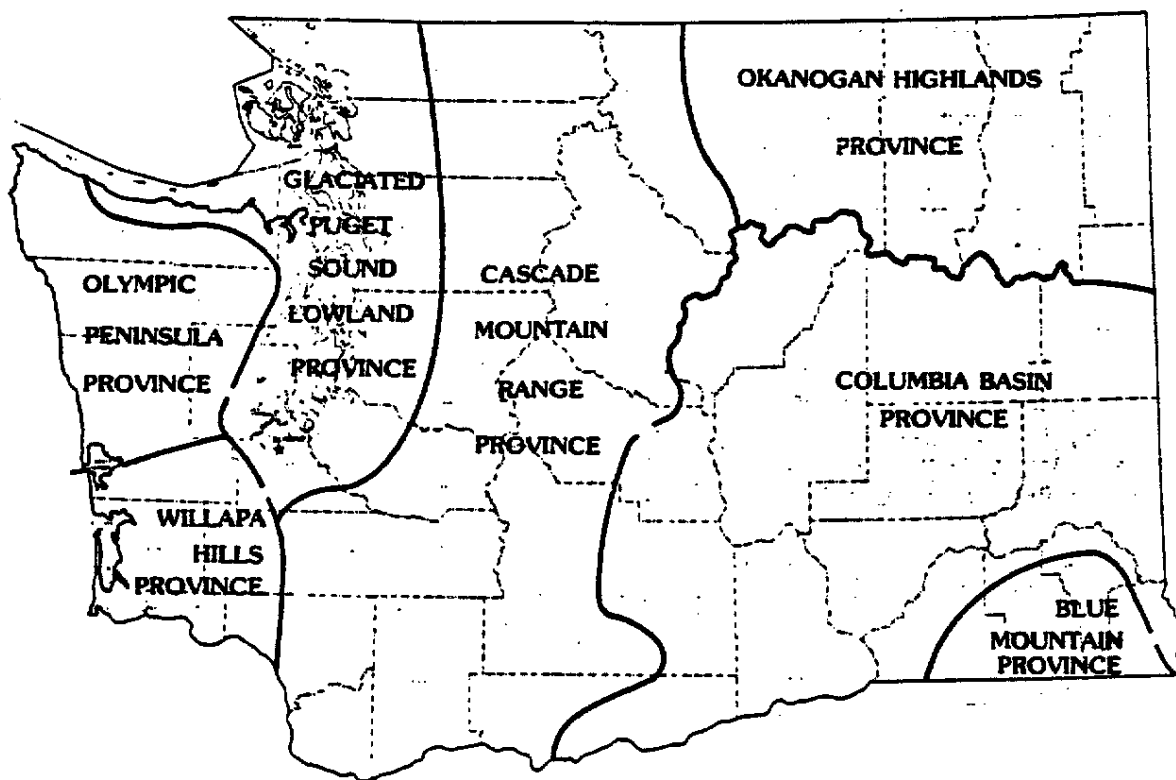


through the sandstone could be trapped by the overlying clay or shale due to the pinchout of the sandstone. Folding and bending of the rock layers may be followed by erosion and truncation of some layers and subsequent deposition of other flat-lying layers. If an impermeable layer is deposited over the permeable layer, a trap may be formed. In the deposition of some layers, lenses of permeable rock may be deposited within more extensive impermeable material forming a trap. Finally, in the deposition of a rock layer a change may occur in the material being deposited. For example, sand may be deposited with fine-grained silt or clay in some areas. This fine-grained material may provide a permeability trap to the migration of oil or gas.

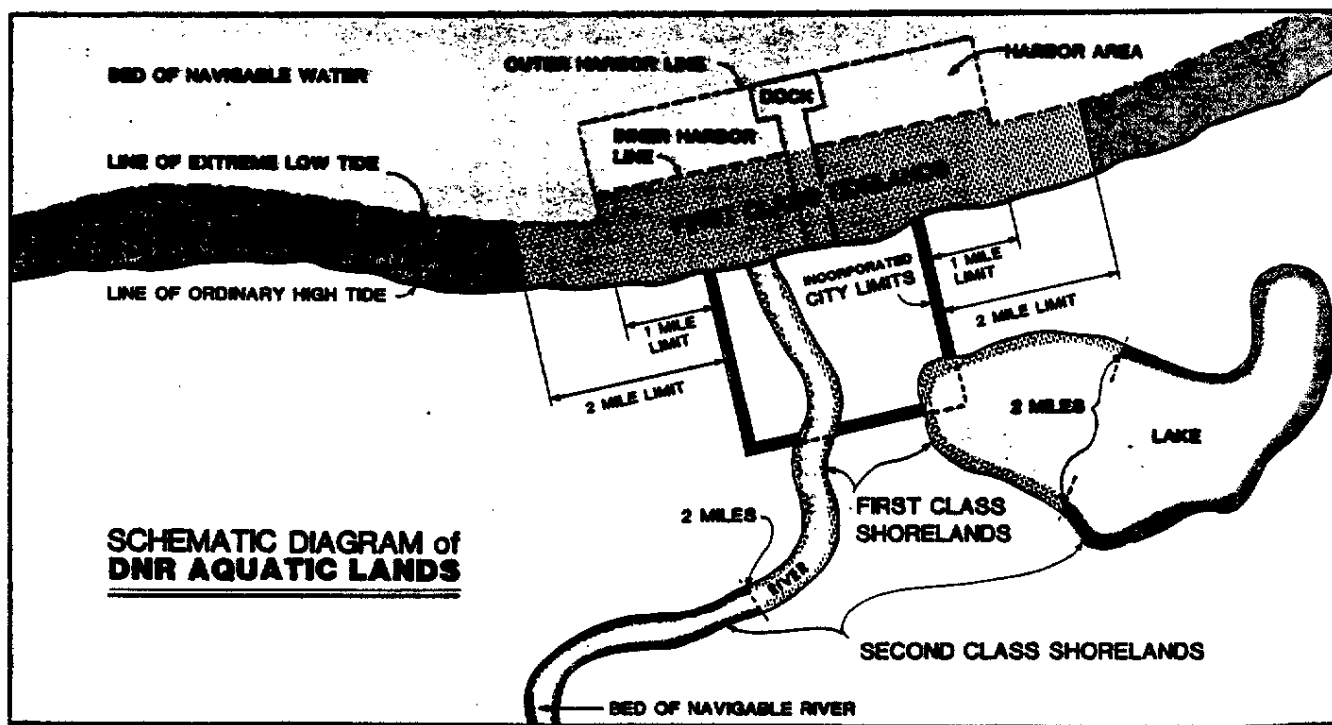
The department's Forest Land Management Program Environmental Impact Statement (FLMP EIS) (DNR, 1983a) extensively describes general state-wide environmental conditions by element of the environment. The FLMP EIS divides the state into seven physiographic provinces: the Olympic Peninsula, the Willapa Hills, the Glaciated Puget Sound Lowlands, the Cascade Mountain Range, the Okanogan Highlands, the Blue Mountains and the Columbia Basin (see Figure 2). Each province has its own unique combination of geological and other environmental characteristics. In many cases, boundaries between provinces are transitional, with a mix of certain features at the boundaries. (See Appendix C for a detailed description of the geology and soils found in these provinces.)

Aquatic lands owned by the state include 11 square miles of harbor area, 140 square miles of shorelands and 205 square miles of tidelands. (See Figure 3.) The state's ownership also includes the beds of all navigable waters within 3 miles of shore and all the bedlands of the Puget Sound. The department's draft Aquatic Land Policy Plan (DNR, 1984a) describes the basis for asserting ownership to these lands. Proposed oil and gas activities on, under or near waters of the state require completion of the SEPA process. Further discussion of affected aquatic lands will be part of that process.

**Figure 2 Physiographic Provinces**



**Figure 3 Department Aquatic Lands**



## OVERALL MANAGEMENT DIRECTION

The department believes that coordinated planning between management programs can provide income to the state and the trusts from a variety of activities, yet maintain a healthy natural environment for present and future generations.

~~((During the last year))~~ In 1984, the department adopted a management plan for department-managed forest lands and issued a proposed policy plan for aquatic lands. Since the Oil and Gas Leasing Program affects both forest and aquatic lands, the goals of their management plans are repeated here. The Oil and Gas Leasing Program goals further define forest and aquatic land management.

### FOREST LAND MANAGEMENT GOALS

Conserve and enhance the natural resources of state forest land.

Provide a sustained yield of timber through intensive forest management.

✓ Integrate the needs of nontimber resources into the management of the timber resource.

Protect from major losses, such as those caused by fires, insects, animals and diseases.

Provide financial support that balances the level and flow of revenue to the trusts.

Provide for both the short-term and long-term needs of the trusts.

✓ Diversify management practices to moderate economic risks.

✓ Anticipate and respond to market opportunities.

Provide social and economic benefits.

Provide for multiple use on forest land.

Contribute to the viability of the forest products industry.

✓ Contribute to state energy production.

### AQUATIC LAND MANAGEMENT GOALS

Conserve and enhance aquatic lands and associated resources.

Meet or exceed environmental quality standards.

Maintain or improve the productivity and usefulness of aquatic lands.

Provide high quality habitat for wildlife on state aquatic lands.

Provide social and economic benefits.

Promote access to and recreational use of state aquatic lands.

Encourage water dependent uses.

Promote the production on a continuing basis of renewable resources.

✓ Allow suitable state aquatic lands to be used for energy and mineral production.

Generate income from use of aquatic lands.

## **OIL AND GAS LEASING PROGRAM GOALS**

**Conserve and enhance the natural resources of state lands.**

Integrate oil and gas resource management with the management of other state land resources.

Protect from and reduce or eliminate losses caused by erosion, pollution of ground and surface waters and disruption of wildlife habitats.

**Provide financial support.**

- ✓ Provide a financial yield from oil and gas activities through lawful land management.

Provide for both the short-term and long-term needs of the trusts and the public.

- ✓ Anticipate and respond to varying levels of oil and gas industry activities.

Integrate land uses to moderate economic risks.

**Provide social and economic benefits.**

Provide for multiple use on state lands.

- ✓ Contribute to the potential of the oil and gas industry.
- ✓ Contribute to state energy production potential.